

Standard Operating Procedure (SOP)

Cover Sheet

Division serial number A-03-007-SOP

(Assigned by Division EH&S Officer after approvals)

Issue Date: 29 July 2006	
Title: Operation of High Voltage Electron Gun or High Voltage Field Emission Test Stand in the Injector Test Stand South Cave	
Location: Test Lab Injector Test Stand South Cave (Bldg. 58 Rm. 127) & Control Room	
Risk classification (See EH&S Manual Chapter 3210)	Without mitigation measures: 4 With specified measures implemented: 1
Author(s): Joseph Grames	

Supplemental technical validations:	
Hazard reviewed:	Reviewer signature:
Laser	P. Hunt
Electrical	B. Merz
Ionizing Radiation	
LOTO	

Signatures
EH&S staff reviewer:
Division EH&S officer approval:
Department or group approval:
Other approval(s):

Distribution:

Copies to: affected area, authors, division EH&S officer, EH&S Reporting Manager



Standard Operating Procedure (SOP) Injector Test Stand South Cave

1. GENERAL

The purpose of this SOP is to detail the safe operating procedures for the experiments conducted in the Injector Test Stand South Cave. The experiments may use either a High Voltage Field Emission Test Stand or a High Voltage Electron Gun and beam line. Note: the South Cave is separated from the North Cave by a lead wall and lead door; see layout in Appendix A.

Typical experiments:

The High Voltage Field Emission Test Stand is a UHV vacuum chamber with components that may be energized by a high voltage power supply to characterize field emission for different cathode and anode designs and materials. While electron emission may take place (typically less than 1 uA at 120 keV) the purpose of the test stand is not to make an electron beam.

The High Voltage Electron Gun and its associated beam line is composed of UHV vacuum chambers with components that may be energized by a high voltage power supply capable of producing an electron beam current (up to 16 mA at 120 keV). The electron beam is transported through a beam line to a lead shielded Faraday cup.

Joe Grames is responsible for ensuring safe operation of the South Cave. The list of authorized equipment operators in the South Cave is included in Appendix B. This document is posted the Injector Test Stand Control Room (Bldg 58, Rm. 129B). Authorized operators typically include the Electron Gun Group, the Free Electron Laser Gun Group and collaborators.

Hazards:

Hazards associated with the operation of the South Cave include exposure to high voltage, ionizing radiation, laser radiation and oxygen deficiency. All hazards are mitigated to a Risk Code 1 by the use of engineered controls and administrative procedures. In case of emergency, contact appropriate emergency personnel and notify Joe Grames (x7097) and/or Matt Poelker (x7357).

2. HIGH VOLTAGE

The unique high voltage power supply for the High Voltage Field Emission Test Stand and High Voltage Electron Gun is located in a grounded rack (Rack 05) in the control room (Bldg. 58 Rm. 129B). Independent high voltage cable is used to connect each



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apparatus to the high voltage power supply. Consequently, only one apparatus is energized with high voltage at any time. Each cable has a commercial termination with a distinct ground loop connection and interlock connector. The two high voltage cables pass through an overhead cable tray into the south cave and connect to the Field Emission Test Stand and Electron Gun.

The high voltage hazards include electrical shock or burns. The hazards are mitigated by:

1. Engineering Controls:

- High Voltage Enable interlock circuit
 - Grounding loop chain interlock with PLC device
- (A block diagram of the interlock chain is included in Appendix C)

2. Administrative controls:

- Warning beacon at rear entrance labyrinth door
- Warning beacon at north cave entrance lead door
- Locks and interlocks on entry doors
- Procedures for controlling high voltage

Electromagnets powered by external trim cards exist in the south cave. The current (<10 A) and voltage (<30 V) are low, requiring no special precautions.

The interlock system in the south cave will be tested every six months to ensure proper operability.

Mitigation of high voltage hazards is accomplished by restricting personnel from the south cave when high voltage is enabled. Procedures designed to ensure that there is no risk of exposure to high voltage are described in Section 6 Operating Procedures.

3. IONIZING RADIATION HAZARD

The High Voltage Electron Gun and High Voltage Field Emission Test Stand are capable of producing electrons at 120 keV. The High Voltage Electron Gun may produce electron beams at currents up to 16 mA. Typical field emission current from electrodes used in the High Voltage Field Emission Test Stand will be less than 1 μ A. The prompt ionizing radiation hazard is due to x-ray emission caused by electrons impinging on material. Ionizing radiation hazards are mitigated by:

Engineering Controls

- The HV enable interlock chain is broken when either the crash button in the control room is pressed or when the magnetic switch on the door is opened.
- Concrete shielding at least 12" thick surrounds both Injector Test Stand North and South Caves, Bldg. 58, Rm. 127.
- Lead shielding (1/8" thick) surrounds the South Cave Faraday cup.
- A lead lined wall separates the North Cave and the South Cave. There are two layers of 1/16" lead sheet bonded to sheet rock in this wall, and a lead lined door.



The lead lined wall separating the North Cave and South Cave has been certified by the Radiological Control Group.

Hazard	Risk Code	Consequence Level	Likelihood Code
Prompt X-ray emission	4	III	D
Electron beam at 120 kV	3	IV	B
Prompt radiation from dump	4	III	D
Prompt radiation exiting the cave	0	I	A

Administrative Controls:

- Magenta beacons are activated when high voltage interlocks are armed, indicating potential for ionizing radiation inside the cave.
- Alarming Radiation Monitors (CARM) in both the North Cave and South Cave.
- A beam permit warning light indicates the status of the South Cave.
- Personnel are required to wear dosimeters in the North Cave when the South Cave is capable of high voltage. Visitors may be escorted into the North Cave without dosimeters provided that the South Cave is not capable of high voltage.

Mitigation of ionizing radiation hazards is accomplished by restricting personnel from the south cave when high voltage is enabled. Procedures designed to ensure that there is no risk of exposure to ionizing radiation are described in Section 6 Operating Procedures.

4. LASER HAZARD

Laser standard operating procedures (LSOP) are posted in the Control Room (Bldg. 58, Rm. 129B). LSOP #A-05-005-LSOP addresses the South Cave and LSOP #A-04-001-LSOP addresses the North Cave. Laser hazards are mitigated through use of Class 1 interlocked laser enclosures during operation and laser goggles and interlocked secured access during alignment.

In summary, hazards associated with the lasers are mitigated by:

Engineering Controls:

- The laser light will be contained within a Class 1 interlocked laser enclosure.

Administrative Controls:

- Laser standard operating procedures (LSOP) govern all laser system work. Personnel are trained and work in accordance with these procedures.
- Personnel must wear protective goggles during alignment mode when the Class 1 enclosure mode is bypassed.
- Warning signs are posted in the test cave area at entry locations and on the Class 1 laser enclosures.



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- Laser warning beacons are posted at entry locations to the South Cave to notify personnel when alignment mode occurs.
- All personnel working on the laser have proper laser training.

5. ODH HAZARD

The South Cave is classified as an ODH 0 area and requires ODH training. Up to 5 untrained visitors may be escorted by each ODH trained worker after providing an ODH briefing.

6. OPERATING PROCEDURES

Procedures to sweep the South Cave to Beam Permit, Enable or Disable High Voltage to either the Field Emission Test Stand or Electron Gun, and for re-entry to the South Cave following Beam Permit are detailed here.

Sweeping the South Cave

1. Push the South Cave interlock chassis crash button to reset and ready for arming.
2. Remove the interlock chassis keys.
3. If the North Cave is
 - a) **beam permit** then the Sweeper should enter the South Cave from the rear exit door and proceed to the lead wall doorway and close the lead door.
 - b) **not beam permit** then the Sweeper should enter the North Cave and notify all personnel that the South Cave will be swept. The Sweeper should test the North Cave CARM by pressing the test button and observing a continuous audible alarm. The Sweeper should proceed through the lead wall doorway and close the lead door.
4. The South Cave will be swept only by the Sweeper. If there are other personnel present they must exit the South Cave.
5. At the lead door arm the CRASH box – LED turns from red to green.
6. Test the South Cave CARM by pressing the test button and observing a continuous audible alarm.
7. If beam is to be run then verify that the HV grounding chain is made up in two places:
 - a) where the HV cable attaches to the top of the HV shroud
 - b) where the base of the HV shroud attaches to the chamber.
8. Exit the South Cave and turn off the overhead lightning.
9. Lock the door deadbolt.
10. Arm the Crash Box – LED turns from red to green.
11. Return to control room and return the key to the interlock chassis.

Enabling High Voltage in the South Cave

1. Prior to sweeping the South Cave ensure the appropriate high voltage cable at either the Field Emission Test Stand or Electron Gun is mechanically connected and the corona shield is seated in place. Connect the appropriate high voltage cable grounding interlock chain.



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2. Perform a sweep of the South Cave.
3. Remove the administrative lock from the high voltage cable to be used and insert into the Glassman High Voltage Power Supply.
4. Complete the ground chain interlock circuit by connecting the interlock cable at the back of the HV power supply to the one attached to the high voltage cable.
5. Turn Glassman High Voltage Power Supply ON/OFF switch to ON.
6. From the South Cave interlock chassis control screen verify that:
 - a. The laser shutter is closed,
 - b. The 15 degree bend magnet (MDSHG04) is set to $-2.2A$,
 - c. The 100 kV enable button is in the off position.
7. Press the "Push to Reset" button on the South Cave interlock chassis. The "Start 100 kV" LED should illuminate.
8. Set the MEDM "100 kV Enable" to ON.
9. The high voltage can then be ramped up using the dials located on the Glassman High Voltage Power Supply (manual mode) or ramped to 100 kV (automatic mode).
10. Once at operating voltage the laser shutter can be opened and beam can be run.

Disabling High Voltage to the South Cave

1. Ensure the laser shutter is closed.
2. Ramp the high voltage off using the dial (manual) located on the Glassman High Voltage Power Supply or toggle switch (automatic) located on the HV ramp controller.
3. The Glassman High Voltage power supply (120 kV, 16 mA) is then turned disabled:
 - Setting the power switch on the power supply to OFF,
 - Set the MEDM "100 kV Enable" to OFF,
 - Notify personnel that the high voltage power supply will be locked out,
 - Disconnect the ground chain interlock at the rear of the power supply,
 - Verify the grounding chain LED on the interlock chassis is red,
 - Remove the high voltage cable from the rear of the power supply,
 - Ground the high voltage cable to the grounded sheath and then insert into the sheath, and
 - Apply an administrative LOTO device keeping the high voltage cable in the sheath.

Entering the South Cave after Beam Permit

1. Remove the South Cave interlock chassis control keys.
2. Unlock the deadbolt at the rear South Cave doorway.
3. If the South Cave CARM is alarming then stop activities, leave the area, re-lock the door and contact the Radiological Control Group.
4. Turn on the South Cave overhead lights at either entrance door.
5. Touch the corona shroud and high voltage cable with a grounding rod.
6. Note: The time it takes to disable the high voltage power supply should be adequate for static charge to dissipate, so grounding the corona dome is meant to verify that the static charge has indeed dissipated.
7. If the corona shield is to be removed then:



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- a) Touch the grounding cable to the corona shield as you approach the gun.
 - b) Remove the interlock cable from the corona shield thus breaking the HV interlock enable circuit in another location.
 - c) Open the top of the corona shield and run the grounding rod along the cable as the cable is withdrawn from its dock in the gun. Take care to also touch the tip of the HV cable to the grounding strap as the cable is removed.
 - d) Touch the grounding rod to the gold corona shield of the gun briefly to ensure that this is also grounded. Leave the grounding rod hanging on the HV cable while it is open.
8. Return the South Cave interlock chassis control keys.

7. TRAINING REQUIREMENTS

The training requirements to operate equipment in the south cave are:

- Radiation Worker I
- Laser Safety
- Lock, Tag and Try
- Oxygen Deficiency Hazard (ODH)
- Training for this SOP

Visitors to south cave must be escorted at all times by trained personnel. In specific cases, personnel not on the above list but authorized by Joe Grames may work in the south cave without escort. For example, Radiation Control Group personnel may calibrate a CARM without escort. Dosimeters are required in the south cave when the north cave is in beam permit.

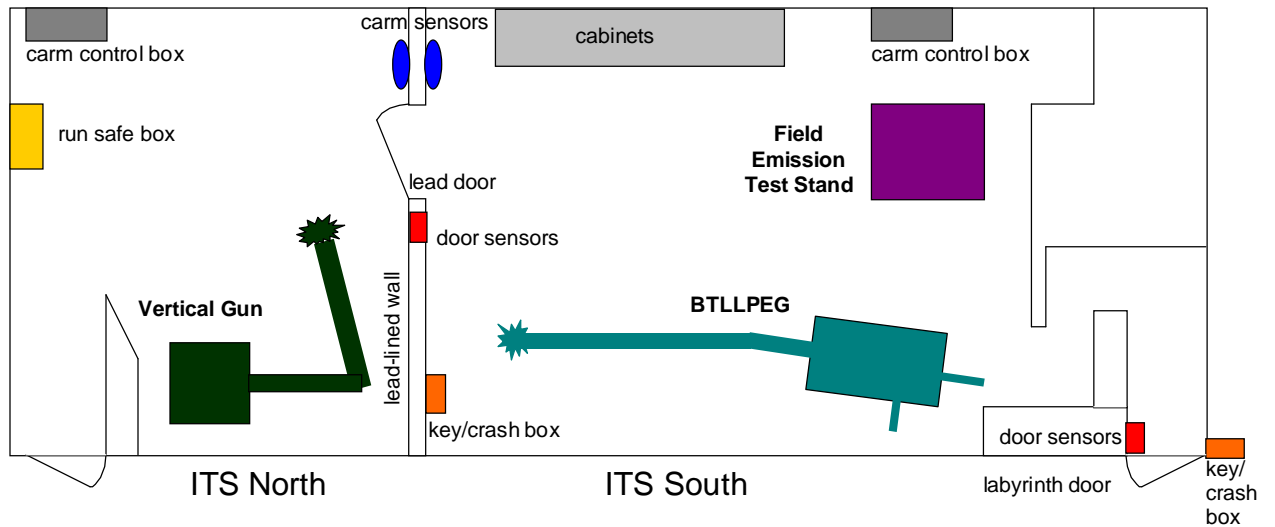
Approved personnel are listed in Appendix B.



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APPENDIX A



Injector Test Stand, Bldg 58, room 129



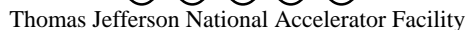
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APPENDIX B

The following personnel have met the training requirements in Section 7 and may operate the High Voltage Field Emission Test Stand or High Voltage Electron Gun and associated beam line.

Print Name	Sign & Date



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